PRACTICAL WORKING

OF THE

GELATINE EMULSION PROCESS.

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BY

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PREFACE.

During the last two years, such rapid progress has been made in the gelatine emulsion processes that the Author has ventured to collect in a compact form such practical working details as will enable any careful photographer to prepare his own plates, and to develop them satisfactorily. No theoretical considerations have been introduced into this work, as they have been fully treated of by the Author in the Handy-Book entitled "Emulsion Processes in Photography," to which the present work is a Supplement. Every process and manipulation has been practically carried out by the Author, and nothing has been taken upon trust.

London, 12th June.

INDEX.

THE GELATINO-BROMIDE PROCESSES.

CHAPTER I.

INTRODUCTION.

The present state of the gelatino-bromide process is one of extreme sensitiveness, some plates being so rapid that it is believed that they require but about one-sixtieth of the exposure of wet plates. Under these circumstances it is quite conceivable that light of such a feeble character that it would not affect a wet plate during any reasonable amount of exposure to it might still be able to fog a plate which is so exquisitely sensitive. For instance, it is not only probable, but it is a fact, that in the dark rooms as most usually to be found a transparency might be printed on a wet plate, by means of the light coming through the yellow or orange glass of the window, by one hour's exposure. Supposing that a gelatine plate to be only sensitive to the same *quality* of light as a wet plate, it is evident that an exposure of a minute to such a light would be amply sufficient to fog it hopelessly. Regarding the light to which

it is *not* sensitive, a fuller explanation will be found in another chapter.

Testing the Camera and Dark Slides.—Before attempting to work gelatino-bromide plates, the camera should be rigidly examined. The aperture in which the lens screws should be blocked up, and the ground glass raised or withdrawn. A cloth should then be placed over the back, but not over the bellows, and any small pinhole searched for. If any be found, a little black paper should be pasted over it, and varnished with lampblack in shellac. With a new camera by a good maker this is not likely to occur, but, at all events, it is a wise precaution to take. The next apparatus examined should be the dark slides; and here particular care must be taken. The best plan is to place sensitive gelatine plates in them, and expose both back, front, sides, and ends of the shut slides to direct sunlight, if possible. The plates should then be treated as if exposed, and the developing solution applied. It is very probable that lines may be found across the plate where the front of the slide is hinged and turns back. It seems in this case almost as if light travelled round corners, but it is, in reality, the reflection—or, rather, the re-reflection—of the light striking the inside of the rebate, and so falling on the plate. If a line does make its appearance, a little lampblack in gelatine should be applied, to darken the surfaces of the wood where the front hinges, and this will generally stop all mischief. It must be recollected, however, that a slide containing gelatine plates should be exposed as little as possible to daylight, but should always be covered with a dark cloth.

Testing the Lenses.—The next point to attend to is the lens or lenses, particularly the lenses with rotating

stops. If the head be placed beneath the dark focussing-cloth, with the focussing-screen withdrawn, and the cap on the lens, it will be found that there is a certain amount of illumination of the stop—faint, it is true, but still sufficient to fog a plate if it be exposed for long to it, as would often be the case when a picture is being taken on a windy day, and the cap is replaced for long intervals. It will be found very easy to unscrew the part of the lens holding the diaphragms, and to cover it with a light-tight layer of velvet, gluing it on to its place. In default of this, the brass mounting of the lens should be shielded with a piece of black cloth. These precautions may appear to be ridiculous, but in sober truth they are not: they are an absolute necessity. Again, during exposure a dark cloth should always be thrown over the back of the camera, to cover the slide, as sometimes, despite all its apparent safety, light may find an entry.

Instantaneons Shutters.—One of the great charms of the gelatine plate is the possibility of taking so-called instantaneous views—that is, with an exposure of from one-fifth to one-hundredth part of a second—and every camera should be fitted with an instantaneous shutter of some kind. The simplest, if not the best, of which the writer knows, is one designed by Mr. William England, and is on the old plan of causing an aperture, of a size varying at will, to drop by the action of gravity behind the lens. There are many shutters which drop in front of the lens, but this position is wrong, since then greater exposure is given to the sky than to the foreground. England's shutter is made, or will be made, by most camera-makers, and with an aperture of a couple of inches gives an average exposure of about one-fifteenth of a second.

It is not in the province of the work to describe apparatus, but it is to recommend it, and this we do without hesitation. For instantaneous work a lens of large aperture should be used, such as the rapid rectilinear or the rapid symmetrical lens, and the largest stop that will give fair definition should be used, and then the shutters can be used to give very short exposures, a desideratum when moving figures are in the immediate foreground. In regard to the camera legs, they should be solid, since a sudden gust of wind will do more harm during a short exposure than it would when the exposure is prolonged.

Regarding Exposures, but little has to be said; those who have been accustomed to work wet plates should judge what exposure they would give when so doing, and should then divide the time necessary by the constant denoting the rapidity of the plates. Some photographers, when working with ordinary dry or wet plates, are accustomed to put their own caps on the lens or in front of it whilst, perhaps, there is movement amongst foliage. This will not do for gelatine plates; the cap of the lens, or its equivalent, must be absolutely replaced, or the light reflected will fog the plates. The very illumination of the glass of the lenses will often cause fog, if the exposure be prolonged and any portion of the subject be brilliantly illuminated. The use of stops much modifies the mischief. This is a rare defect, however, and need scarcely be entered into, except as showing how an evil can arise.

Cases for Camera and Dark Slides.—The camera and dark slides for out-door work should be carried in cases, leather, perhaps, being the most useful. For a small

sized camera, such as $7\frac{1}{2}$ by 5, the slides and camera can be fitted into the same one, without any inconvenience. Above all things, the slides should be capable of being locked up. Curious chamber-maids and hotel porters are thus placed at a disadvantage to themselves, but the reverse to the photographer.

CHAPTER II.

THE DARK ROOM AND ITS FITTINGS.

Illumination of the Dark Room.—There is more truth in talking about the developing and preparation room for gelatino-bromide plates being "dark" than is usually the case. This is one of the drawbacks to their adoption, though it will be seen further on, at p. 21, that if the quality of the light be correct, the quantity may be unlimited, though only for a modified process. There are so many persons attempting to prepare gelatine plates who fail, that, perhaps, the first point on which to touch is the nature of the light which can be admitted. To make this more clear a diagram from another work* is reproduced, from which a notion can be obtained as to the light to which different plates are sensitive.

No. 1 may be omitted from consideration, but Nos. 3, 4, and 5 should be studied. When a streak of white light is passed through a prism it is spread out into its component colours, and in 14 they are represented as white. The black portions in 2, 3, and 4 of the diagram show the rays of light in every case which do not affect a sensitive plate. The white and half-tints represent, as approximately as can be shown in a wood-cut, the relative

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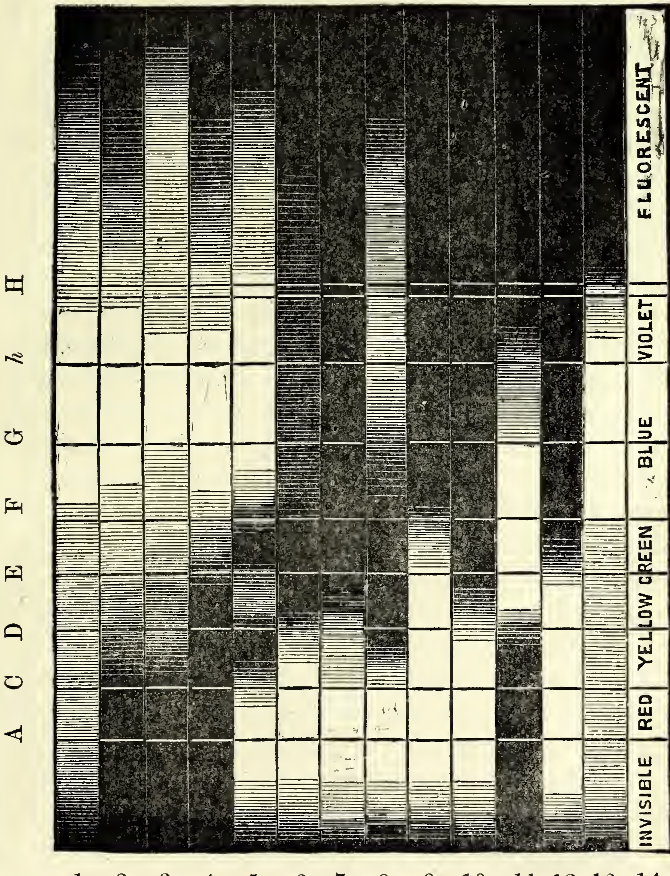
* "Instruction in Photography" (Piper and Carter), 4th edition.

sensitiveness of the plates to the different rays forming

Fig. 1.



1, Special collodio-bromide; 2, gelatino-bromide; 3, collo lio-bromide; 4, bromo-iodide; 5, cobalt glass; 6, ruby glass; 7, chrysoidine; 8, magenta; 9, flashed orange; 10, stained red glass; 11, bottle-green glass; 12, aurine; 13, quinine.

white light; the degree of sensitiveness being indicated by the degree of whiteness. It will be noticed that the gelatino-bromide and collodio-bromide plates are sensitive to the confines of the red, and some specimens of the former are also sensitive well into the red, whilst the bromo-iodide is only sensitive to the confines of the yellow. Next we need only turn our attention to Nos. 5, 6, 7, 8, 9, 10, and 12. In these are shown the rays of light which pass through different coloured glasses and dyes. Ruby glass would be a perfect protection for nearly every plate were it not that a certain amount of blue light passes through one thickness of it. When two thicknesses arc used the blue is imperceptible. By the use of orange glass and ruby, or stained red glass and ruby, light passing through these double thicknesses is such as will not affect most of the sensitive plates, since the orange or stained red entirely cuts off the blue which may permeate the ruby glass. Several persons with whom the writer has come in contact have told him that they prepare plates so sensitive to the red that the light passing through any number of thicknesses of ruby glass proves an ineffectual protection to the plates they prepare. Unless ruby glass were added till total darkness supervened, there is nothing to surprise us in this statement, as the red light which filters through three or four thicknesses of ruby glass has the same quality as that which filters through two thicknesses. What they really express is that they prepare plates which are in reality sensitive to red light. When this is the case, the development and preparation of such an emulsion becomes a nuisance, and is probably more of a scientific than of a practical value, since the same sensitiveness can be produced without any liability

to veiling of the image through the impact of light of such low refrangibility on the plate. For an ordinary dark room we recommend that, if a north light be obtainable for the window, one thickness of ruby and one of stained red or orange glass be employed. As to dyes, it will be seen that if glass be coated with aurine on one side, and magenta on the other, the same spectral quality will be obtained. If plates very sensitive to the red be prepared, one thickness of cobalt glass and one of stained red will be the best combination to use; but, as we said before, plates requiring such a light to develop by should not find a place in a photographer's hands. If the sun shine on the window during any part of the day, it is well to have a screen, which can be placed against the window frame (it can be hinged from the top and pulled up as a flap by a small pulley arrangement), covered with orange-coloured paper. This diffuses the light, and renders any chemically active rays which can possibly filter through it less hurtful. It is not always practicable, however, to work by day, and then it becomes necessary to resort to artificial light, and that must be of the same character as the filtered daylight. Now, candle and gas light have not the same amount of blue in them as the light from the sun, hence the screen used for shielding such sources need not be quite so perfect. In our practice we have a common stable lantern fitted up for this purpose. Holes are pierced at the bottom of it for the indraught of air, and holes at the top of the sides for the outdraught. To prevent any light striking the ceiling, we have had a tin cover fitting round the lantern* at the top,

* Some lanterns are made with this arrangement.

and sloping 45° downwards, by which means any light glancing through the holes strikes the shade and is reflected downwards.

A sort of stiff crinoline is made as shown in the figure,

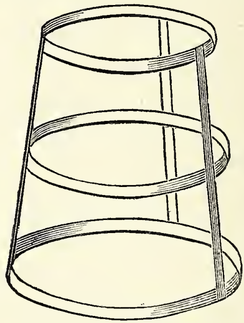


Fig. 2.

and is covered with paper varnished alternately with aurine varnish and magenta. These varnishes can be combined and applied at once. They are formed by dissolving in shellac varnish small quantities of these dyes, then brushing it over bank-post paper, or even ordinary thin Saxe or Rive paper, and drying it before the fire. In a jacket or crinoline made like this, no light except red light can penetrate to the plate, and very excellent illumination is got. By placing a bottom on to the crinoline (which, by the way, can be made of any old hoops, three laths, and string), the lantern may be suspended from the ceiling if found more convenient. For our own part we prefer light to come from about the height of one's waist, since all operations can then be distinctly seen. A couple of these lanterns give a *luxurious* light. They can be adapted for gas if required, though usually they are made for candles. A travelling lantern can be

purchased now of most photographic dealers, but does not give such an abundant light as that we have described. Some dry plate men we know have gas burning close outside a ruby glazed window which opens into an adjoining room, but it is not every one who can have such an arrangement.

Levelling Shelf.—A level shelf is required for the preparation of plates, and this should be large enough to hold at least six plates of the sizes to be prepared. A piece of thick plate glass, or a thick slate with a smooth surface, is either of them good for the purpose. Our inclination is towards the former, since it can be more readily kept clean and bright. The shelf must be accurately level. The table on which the shelf rests must be firm, and not a ricketty "one-pillared" affair, but standing on four good legs, each of which touches the ground. For details of levelling, see page 28.

The Drying Cupboard is another essential for the dark-room, and may be made after one or two plans. It may be made after the model described by Dr. Van Monckhoven, or else after a pattern which is, perhaps, better, and is certainly simpler, and which the writer copied from Mr. England, and used with the greatest success.

The plan recommended by Dr. Van Monckhoven is one which has long been in use in England, but he has described it as follows:—"The drying-box (fig. 3) is easily made, and consists of a box of thick wood, on the top of which is a zinc pipe to connect it with a chimney. At the bottom is another pipe, but with an elbow to prevent light from entering. Horizontal shelves are placed in the interior, so that the current of air obtained by the draught in the chimney goes over each, one after the other. This

box ought to be placed in a warm and very dark room."

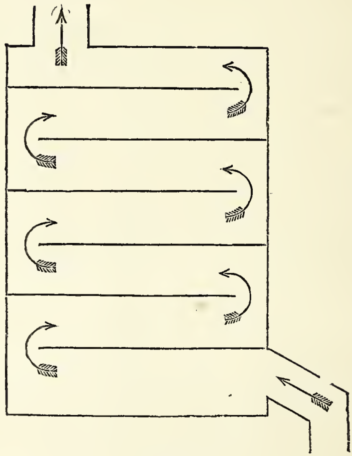


Fig. 3.

As to the necessity of warmth in the room we demur. It is not necessary if arrangements be made for burning a gas jet in the top tube, so as to create a draught.

The next diagram (fig. 4) will give an idea of Mr. England's plan for plates up to 12 by 10 inches. A box is made of the dimensions given, and one side is hinged, and opens as shown. This side has a fillet placed round it, so that on shutting up no light can enter the interior of the box. Through the centre of the box runs a gas pipe, at the bottom of which is inserted a small tube closed at the end, and on the side of which is pierced a small hole. To this hole gas is led, and a very small jet is lighted in the gas pipe. At the bottom of the box, and at the top, are two holes of about three to four inches diameter, and above two tin tubes, some twelve

inches long, are fitted into these tubes as shown in the diagram. It will be noticed that the gas piping

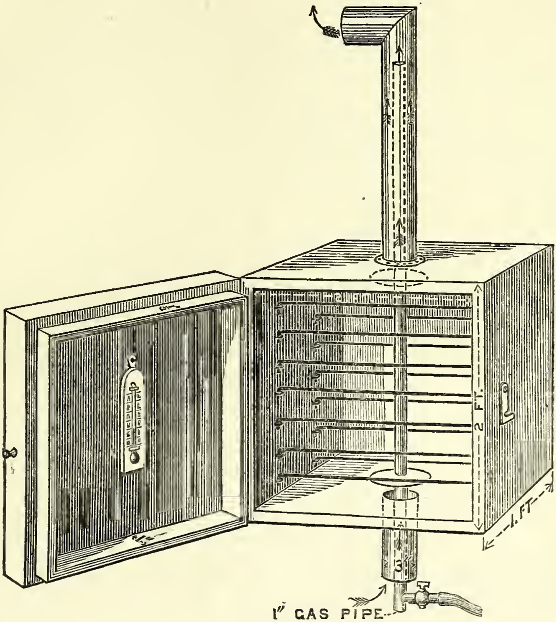


Fig. 4.

passes through the centre of these two tubes. Round the gas pipes are fitted two discs of blackened card or tin, one of which is placed two inches above the bottom hole, and the other the same distance from the top hole. These prevent light striking down the tin tube into the box. The plates, when set, are laid on pairs of wires stretched across the box, as shown in the diagram, and a box of the above dimensions may take from half to one dozen plates on each side of the central pipe.

Plates dried in such a drying box are ready for use

four or five hours after coating. A small thermometer should be hung on the cupboard door, to enable the temperature to be noted.

The rationale of this fairly rapid drying is that the gas piping gets heated, warms the air in contact with it, which ascends through the top tin tube, and a current of fresh air comes up through the bottom one. A constant change of air, more than a very dry or hot air, is the object to be attained.

Plates may also be dried in an open room if it be kept rigidly dark. Drying in cupboards in which there is no draught is a very slow operation, sometimes taking as long as forty-eight hours.

Developing Trays.—An ordinary white dish, a little larger than the plate, is well adapted for the developing operations, though it is rather wasteful of the developer, since the bottoms of such dishes are rarely level, and consequently much of the fluid passes beneath the plate instead of over it. Cast glass dishes can be obtained from most dealers, and these are decidedly better. Dishes of ebonite or papier maché are sometimes used, as also are white enamelled iron baking dishes. The writer prefers a white or transparent bottom to the dishes, since their cleanliness can be more readily ascertained.

Sinks.—A sink, and water laid on above it, are useful, and almost a *sine qua non* for washing emulsions, unless the method suggested by Wratten and Wainwright of using alcohol be employed.

Arrangement of the Dark Room.—Now, as to the position of these requisites, much must be left to the judgment of the worker, and it is also necessarily dependent on the position and size of the dark room. It may be

remarked that a place six feet square is a space large enough in which to work comfortably, but then the arrangement of the room must be adapted to it.

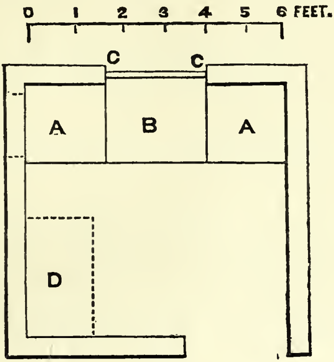


Fig. 5.

A sample of an arrangement is given in the figure. B is the sink; AA are two working tables. On the left, over A, may be placed a glass shelf, running along the left wall towards the drying cupboard D. The right hand table A may be used for the developing bottles and apparatus. The door of the dark room should open outwards, if possible, and be covered by a curtain, which depends on to the ground, thus shutting out all light which would otherwise get through the chink between the door and the floor. Too many precautions to exclude white light cannot be taken, since gelatino-bromide, if it is to take the place of collodion, should be extremely sensitive to it, however feeble it may be.

CHAPTER III.

ON THE CHOICE OF MATERIALS.

Gelatine.—The first material that naturally presents itself is the gelatine, and there is much uncertainty regarding it, since no two specimens are absolutely alike. For our purpose, we may divide it into two classes, one the hard form, and the other the softer specimen. Typical examples of these may be found in Nelson's X opaque gelatine, and his No. 1 (photographic) respectively. To use a hard variety of gelatine alone is a drawback, since it renders a plate difficult of development, owing to the repulsion, as it were, of the film for the developing solution, and the use of soft gelatine alone is equally to be avoided, as the evils of frilling and dissolving of the film which give rise to a reticulated image, are usually to be met with. Our own experience is, that a judicious mixture of the two specimens is the most advisable. Certain of the French gelatines are excellent for admixture, such as Coignet gold medal gelatine; but there are certain disadvantages connected with this special kind, which are not to be met with in others. It has a certain amount of grease clinging to it, which on preparation of an emulsion causes semi-transparent spots in the dried film, and on development there are patches of dullness from the same cause.

Precipitation of this gelatine will get rid of the evil (see "Miscellaneous Notes"), and it is then the very best specimen of gelatine to use when mixed with a softer kind, such as Nelson's No. 1 photographic. The treatment required is well worth the trouble. Nelson's No. 1 flake is also to be recommended, and has no tendency to the evil complained of, and it is moderately hard. There are some gelatines in the market which are quite unsuitable, being contaminated with inorganic matter, and when this is present in very considerable quantity they should be avoided, since they give rise to no end of troubles.

Again, strongly-coloured gelatines are somewhat objectionable, since the film is apt to be non-actinic, which is to be avoided if possible; as a rule, the most colourless kinds of gelatine are the best for this reason.

The Soluble Bromide for the Emulsion.—Regarding the soluble bromide to be used in the preparation of the emulsion, we think that ammonium bromide is to be preferred. The ammonium nitrate formed by double decomposition seems to have no action on the emulsion, whilst it is not quite so certain that potassium nitrate, which is formed when potassium bromide is employed, is similarly inoperative. This may be so or it may not, but experience has taught us that the ammonium salt is the best, and indeed has hence been almost invariably recommended in the latest formulæ which have been worked out by many distinguished experimentalists.

The bromides of heavy metals are to be avoided, since they often perceptibly react upon the gelatine before an emulsion is made.

Soluble Iodide used for the Emulsion.—If an iodide be employed, the potassium salt is recommended, since it is

made more stable than the ammonium salt (see page 22 for the impurity to be looked for). The small quantity of potassium nitrate formed will not be found in the least detrimental.

Silver Nitrate.—The silver nitrate may be of the ordinary commercial character, and need not be recrystallized. We have found that the cheapest sample gives equally as good an emulsion as the dearest, and there is certainly a large saving in cost by doing so. The presence of a little chloride, which is often found in the ordinary silver nitrate crystals, is quite immaterial.

Pyrogallic Acid.—In alkaline development the quality of the pyrogallic acid employed is of the first importance, and from our own knowledge we are convinced that it is a mistaken economy to purchase any but the *best English*, as what is sold *under the name of German* is often nearly valueless for the purpose. The English pyrogallic acid has a much cleaner smell (if the expression can be used) than the German.

Neutral Potassium Oxalate.—The potassium oxalate should be strictly neutral, and not alkaline. If on testing with litmus paper it be found alkaline, it should be neutralized by a little oxalic or sulphuric acid.

Ferrous Oxalate.—Ferrous oxalate is of a bright yellow colour when pure. It should be dry and powdery, and readily soluble in the potassium oxalate.

Glycerine.—The glycerine that may be used should be pure, and not contaminated, as it often is. To photographers it is suggested that they should insist on having Price's glycerine.

Water.—There is not much to say regarding the water. If distilled water can be had, so much the better; if not,

filtered rain-water stands next in the order of merit, and then spring water. If it be very hard water, it is recommended that the temporary hardness due to carbonate of mica should be got rid of by boiling the water, and filtering it. This is not a necessity, by any means, but these precautions enable extra sensitiveness to be given to the plates, by taking away from them any matter which is not essential to the preparation of the plate. When using the ferrous oxalate developer, these same remarks hold good.

Sodium Hyposulphite.—There is nothing special to remark about this, as it is generally sold sufficiently pure for all photographic purposes.

Alcohol.—It will be noted that it is recommended to use alcohol to the emulsion previous to coating the plates. It is better to use absolute alcohol, since the small quantity required is not expensive. For rapidly drying plates, methylated alcohol, free from all resinous matter, may be employed.

CHAPTER IV.

GELATINO-BROMO-IODIDE EMULSION.

We propose to give a detailed account of forming one emulsion which may be taken as a pattern on which to form others by any other formula. It will be found to be exquisitely sensitive to the ordinary photographic light, and very slightly to the yellow, which latter quality means that the development and preparation of the plates can be conducted in a room with any quantity of orange light. To prepare the windows for this, the ordinary window panes may be coated with such a material as Thomas's ruby varnished paper, which will be found quite sufficient protection (see page 7); though if direct sunlight beat on the window, it is desirable to have a blind of orange paper or calico, which subdues the light, since the blue rays from a very strong light might pierce the first paper if there are any deficiencies in the varnishing of the paper. Ruby glass and such a screen or curtain is a certain protection, and is convenient, since there is no danger of the colour altering through any chemicals that may be used. Pot-orange or stained red glass, which are about the same materials, would answer equally well. The dyes made

up in varnish, as given at page 9, may also be substituted once more. The ordinary dark-room windows, if covered with red tissue paper such as is supplied for fancy decorations, will render the light safe. The reader must remember that tricks cannot be played with the light of the dark-room, such as are admissible when the comparatively slow wet process is used. Thus he should see that no light of the wrong colour penetrates at any place; he should pay particular attention, for instance, to the chinks under the door, and in the sashes of the window frame. When he has come to the conclusion that no daylight is entering his room he may think about preparing the emulsion. It need scarcely be said that all weighing can be done in ordinary light. To commence operations, the following may be weighed out separately and placed on clean* paper after weighing, it being supposed that a dozen or a few more whole plates are required.

1.—Potassium iodide	15 grains
2.—Ammonium bromide	120 ,,
3.—Nelson's No. 1 photographic gelatine	30 ,,
4.—Silver nitrate	216 ,,
5.—Nelson's No. 1 photographic gelatine	80 ,,
6.—Nelson's X opaque gelatine, or Coignet's gold medal gelatine	80 ,,

* Any contamination by dirt of any description, and particularly that to be found in a photographer's work room, is almost sure to spoil the emulsion, or at all events its sensitiveness, and to cause endless evils. Hence *clean* paper should be used, and the chemicals should not be left on the benches or table in contact with the wood.

Nos. 1 and 2 are dissolved in 1½ ounces of water (ordinary tap water is good enough), and then No. 3 is added and allowed to swell in the liquid. It may require a little coaxing to get it beneath the surface of the water, but if a good-sized developing cup be used there will not be much difficulty. When swollen, the cup containing the salts and the gelatine is placed in boiling water for a time, till the latter is dissolved (which it will readily do in a very short time), and raised to the temperature of about 150° F. The behaviour of this mixture must be carefully noted at this point. When some kinds of potassium iodide are used, the solution turns brown. This is owing to the presence of a minute trace of potash with the iodide, and if such decomposed gelatine be used, the resulting plates will inevitably show a green fog or veil by reflected light, and pink by transmitted light. If the darkening of the solution does take place, a drop of a 10-grain solution of iodine in alcohol should be first mixed with the water, and the iodide be then dissolved, and afterwards the bromide and gelatine may be added. The silver No. 4 meanwhile is also dissolved in 1½ ounces of water.

The last is placed in the spray apparatus, which is made as follows :—Bend two thin glass tubes in a common fish-tail burner of the shapes A and B (fig. 6). The tube A should first of all be drawn out so that the end is perfectly closed ; this may be done by the heat of a Bunsen burner, by holding the straight tube over it at about an inch from the end, in the hand, and at any convenient distance in the other, and, when thoroughly softened by the heat at one point, by simply pulling the tube outwards. The glass collapses, and the short bit is pulled off. A flat file is then applied to the point, and the glass filed away

till a very small orifice is left. The two tubes are then inserted in a cork which is fitted into a test-tube as

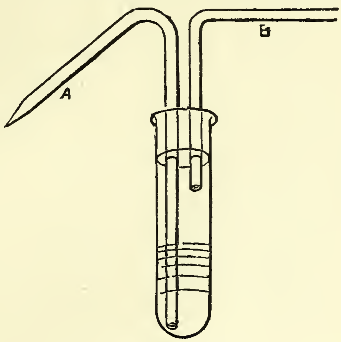


Fig. 6.

shown. The silver nitrate is placed in the bottom of the tube, and a very fine spray of liquid can be forced into the orifice of A.

The gelatine should be placed in a glass beaker or a jam pot, and in the dark room the spray is blown on to it, and the liquid stirred, at the same time, with a clean glass rod. This gives a very fine emulsion indeed, and, if correctly carried out, a drop of it, when poured on a strip of glass, should show an orange-yellow colour by transmitted light. The possible sensitiveness of an emulsion depends almost entirely on the fineness of grain of the bromide when first formed. With a grey or blue-tinted emulsion extreme rapidity can never be hoped to attained. The emulsion should be transferred to a 20 ounce bottle* and *well shaken* for five minutes, after

* Some recommend the use of an earthernware bottle, such as an old ink-bottle. There seems to be no advantage in it if ordinary precautions be taken for keeping out the light.

which it is ready for the next operation. A saucepan of sufficient size to hold the bottle must be procured, and filled with water to a convenient height, and a flame, such as a gas-burner, placed beneath it. After the water has been brought to boiling point, the emulsion is kept boiling for twenty minutes to half-an-hour; it being shaken at intervals (say once every ten minutes) for half a minute or so. A thick cloth tied round the hand prevents any scalding. The boiling, by-the-bye, should take place without the cork being left in the bottle; for if it remain in, it would be blown out by the force of the steam.

After the proper time of boiling, the saucepan is removed. The gelatines Nos. 5 and 6 should, in the interval, be mixed together and swollen up in about 2 ounces of water. After being drained as dry as possible, they are melted at a temperature of about 100° by immersing the pot or flask in hot water, and added to the hot solution in the bottle, which remains in the saucepan. After a good mixing by shaking, the emulsion is left to cool for an hour.

At the expiration of that time the emulsion is poured out into a flat porcelain dish and allowed to set. The time which it will take will vary according to the temperature of the surrounding air, but a couple of hours is generally amply sufficient, and often a much less time will suffice.* When tolerably firm, some cold water is poured on the surface (and if rain-water is at hand so much the

* In very hot weather, if the dish be stood in acid water, no difficulty in setting will be found.

better), as it makes the gelatine set very firmly and resistant. After a proper consistency is obtained (such consistency being that the gelatine should not tear with a moderate pressure of the finger) the emulsion is carefully scraped off the bottom of the dish with a strip of *clean* glass, and transferred to a piece of very coarse canvas which has been previously boiled in hot water to get rid of any grease or dirt. The emulsion is then twisted up in this, and by a gentle pressure squeezed through the interstices, the ball of emulsion being absolutely below the surface of the water into which it is forced. The water causes the threads of gelatine to remain tolerably separate, and as it passes through the liquid most of the soluble salts are at once extracted.

When all is squeezed through, the particles of gelatine may again be transferred to the canvas, and after stretching it loosely over the mouth of the jar (emptied of water), may be doused with water from the tap or from a water jug. After a couple of gallons have been thus passed over it, the emulsion should again be squeezed through the canvas, and the same operation repeated, thus exposing fresh surfaces of gelatine to the action of water. After another sluicing with water the emulsion may be considered as washed, though, to make assurance doubly sure, the gelatine may be left at the bottom of the jar, and the water changed two or three times. To show the importance of thorough washing, the following experiment may be noted. An emulsion was made as above, and after once squeezing through the canvas, a part was immediately used for making plates. A second part of the same was washed under the tap for five minutes; a third part was squeezed and washed a second time;

and a fourth part was allowed to soak, and squeezed a third time. The relative sensitiveness of the four parts was as follows :—

$$1 — 1\frac{1}{2} — 2\frac{1}{2} — 2\frac{1}{2}$$

The first washing increased the sensitiveness to one and a-half, and the second squeezing to two and a-half, whilst the third squeezing and washing had no perceptible effect.

This method of washing is far superior to that given by allowing running water to percolate over the gelatine, cut into strips and placed in a bottle (see page 51). Two squeezes, it is believed, are equal to twenty-four hours' such washing. Gelatine is hard to permeate, and, being a colloidal body, the crystalline salt has hard work to be got through when the emulsion is not finely broken up.

When the emulsion is considered to be properly washed, it is then drained. This the writer generally does over the canvas, though some recommend a hair sieve, but it does not appear that there is much advantage to be derived from its use. The great point in either case is to drain long enough. A couple of hours is sufficient time, and then the emulsion is ready for melting. It should be transferred to a clean jar or jam-pot, and then placed in boiling water till all the gelatine is thoroughly dissolved. A temperature of 120° or more may be given it with advantage. The emulsion, when all additions are made, will be about $6\frac{1}{2}$ ounces. The addition of $\frac{1}{2}$ grain of chrome alum is to be recommended. This should be dissolved in 1 drachm of water, and added with stirring; 6 drachms

of absolute alcohol are next to be added in the same way, when the emulson is ready for filtering. This operation may be carried out in various ways. The writer now uses wet chamois leather which has previously been well washed. This is allowed to rest loosely in a funnel, and the emulsion filters slowly through it, all coarse particles being left behind. It is preferable to filter into a Florence flask, as it will bear heat, though an ordinary medicine bottle will answer if the flask be not at hand. The bottle or flask is again placed in water at a temperature of 120°, and the next operation is to coat the plates.

Now, there is a good deal to say as to the mode of cleaning plates. It is our own practice to immerse the plates in nitric acid and water (1 to 10), then to wash, and next to rub them once with a solution of caustic potash or soda and a little methylated spirit. After a wash under the tap the water should flow quite evenly from off them, when, after a rinse with distilled water, they may be set up to dry, which they will do very rapidly if set on clean blotting-paper. Polishing a plate is a mistake; it only encourages the formation of blisters, as it prevents the adhesion of the film to the glass. Avoid French chalk, or anything but pure water, and then one of the causes of frilling and blistering will have been eradicated. The plates having been cleaned as above, they are brought into the dark room, and, if possible, slightly warmed. If not practicable to do this, it does not matter much, since it is not necessary, but warmth is only an aid to the even and ready flow of the emulsion. The next point to look to is the shelf on which to lay the plates after coating. In our own practice we have a piece of

thick plate glass about three feet long by one foot broad, and quarter-inch thick. This we level by means of three mahogany wedges and an ordinary spirit level. To level the shelf, we place two wedges opposite one another.

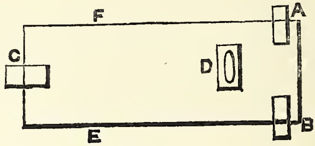


Fig. 7.

The level is placed first across the plate, and the two wedges are altered till the bubble of the level D is central; the level is then turned lengthways along the plate, and the bubble caused to occupy its proper position by shifting C, not touching A or B. This should cause the plate, if true, to be accurately level; but it is as well to see once more if it is so in both directions. A couple of supplementary wedges are sometimes useful at E and F, it the glass "springs" at all. The shelf being level, and placed in a position below the level of the elbow, if possible, a plate is taken on a pneumatic holder, or held upon the tips of the fingers. We will suppose the plate is a $6\frac{1}{2}$ by $8\frac{1}{2}$ plate, that is to be coated. In a warmed measure, about one ounce of emulsion is poured, *taking care that no bubbles are formed* (which can be secured by pouring out the emulsion against the side of the measure), and a pool of gelatine is made at the top of the plate. It is then, by careful pouring, made to fill up the centre of the plate, and flow to the left-hand bottom corner, and, finally, the right-hand bottom corner, where it can be poured off back into the measure. This done,

the amount used is noted, for enough should be on the plate to well cover it, about three drachms being sufficient; and the plate is then detached from the pneumatic holder (if used), held by two corners of the diagonal, and quietly rocked till an even coating is seen to be secured. The plate is cautiously slipped on the level shelf, and left to set. Another plate is taken and similarly treated; and when the shelf is full, the emulsion on the first plate will have set, and it will be ready for removal to the drying box or cupboard (see page 13).

We next come to the drying of the plates. The temperature should be kept as even as possible, sudden changes being detrimental. Very quick drying is a mistake, as the different layers of the film get an uneven strain which eventuates in frilling. Six hours is about the minimum which we can recommend, unless drying by alcohol is resorted to. This can be done by placing each plate, *after thorough setting*, in a dish of alcohol for five minutes, when it will dry in the cupboard in an hour without difficulty. Plates prepared by the above method may be said to be at least twenty times more rapid than wet plates, and it is more exact to give a comparative value regarding this process than it is of others prepared without iodide, since the same rays of the spectrum affect both, and in the same proportions. The exposure can, therefore, be judged accordingly.

Now as to the development of the plate, we come to two methods, both of which are efficacious; but it must be confessed that our leaning is towards the ferrous-oxalate developer.

To develop, the plate is placed in a dish one inch wider each way than itself, and rinsed under the tap

for a few seconds, and the water poured off. In a clean developing cup, one drachm of a saturated solution of ferrous sulphate is mixed with six drachms of a saturated solution of neutral potassium oxalate, which produces ferrous oxalate and potassium sulphate. This is poured over the plate, and the image soon begins to make its appearance, and gradually gains strength. The development is continued till the image appears slightly on the back of the film as seen through the glass plate, after which it is washed, and then flooded for a few seconds with—

Hydrochloric acid	... ...	10 drops
Water	... ...	1 ounce,

to dissolve any oxalate lime that may be formed, and then washed again, back and front, under the tap, and immersed in a saturated solution of alum, as a precaution against frilling. After remaining in this for a couple of minutes it is again rinsed and placed in the fixing bath of a saturated solution of sodium hyposulphite diluted with an equal bulk of water. Both the alum and hyposulphite are most conveniently held in dipping baths, and rough wooden dippers made by screwing on a fillet of wood across a lath is amply sufficient. The fixing will probably take some little time, and should not be done in the daylight, since there is still a chance of producing a veil or fog. This done, for safety sake, a second bath of hyposulphite is recommended by Mr. Thomas, to dissolve out the silver hyposulphite which may be held in solution in the gelatine. The plate is next washed in two or three changes of water, and placed to dry in a rack, if no further intensity to the image be required.

During development, it may chance that the image appears almost too rapidly, in which case the addition of a drachm of bromide of potassium solution (twenty grains to the ounce) is to be recommended. On the other hand, the image may come up slowly; a renewal of the developer is under these circumstances advisable, and will often save a negative from what appears under-exposure. In our own practice, we keep a bottle of a saturated solution of ferrous oxalate in neutral potassium oxalate at hand, and this is far more energetic in its action than ferrous oxalate prepared as given above. A dose of this will often bring up an image, and give intensity which cannot otherwise be obtained. *The stronger and fresher the ferrous oxalate, the greater the intensity that can be obtained.*

The above constitutes what may be called development for normal lighting, and is apt to give too black and white pictures if the contrasts between light and shadow are very marked. To subdue this the ferrous oxalate should be diluted to half strength with water. By this means the picture may be made harmonious, and have none of that chalk-and-soot appearance which so often mars the negative of a brightly lighted subject.

We now come to the development of the plates by the alkaline method, and, of all that we have tried, by far the best is that brought out recently by Mr. B. J. Edwards. The original formula stands as follows: and we quote his remarks on the subject which he made to the South London Photographic Society.

Make two stock solutions, and label them No. 1 and No. 2.

No. 1.

*Pyrogallic acid	1 ounce
Glycerine	1 „
Methylated alcohol	6 ounces

Mix the glycerine and spirit, and add to the pyrogallic acid.

No. 2.

Bromide of potassium (or ammonium)	60 grains
Liquor ammonia, ·880	1 ounce
Glycerine	1 „
Water	6 ounces

The above stock solutions will keep any length of time.

To make the developer, add one part of No. 1 to fifteen parts of water, and label this bottle D (developer). In another bottle mix one ounce of No. 2 with fifteen ounces of water, and label it A (accelerator).

It will be found convenient, to avoid mistakes in the imperfect light of the dark room, to have these two bottles of different shapes. Either of the above solutions will keep two or three days. When required for use, pour into a clean glass measure equal parts of D and A, adding the A last just before using. Place the dry, exposed plate face up in a shallow dish or tray, and pour the mixture steadily over the plate, avoiding air-bubbles.

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* The writer believes that for ordinary work it is better to reduce the pyrogallic acid to ¾ oz., as too much density is liable to grain the highest light with the 1oz.

Should any adhere to the surface of the plate, at once remove them with the finger or a camel's-hair brush kept for the purpose. Rock the dish gently, taking care to keep the plate well covered with the solution. In a few seconds the image will appear, and, if the exposure has been well timed, all the details will be out and the development complete in about one minute, when the negative should be well washed under the tap, and placed at once in the fixing bath.

Do not hurry the development, but allow the plate to remain in the solution after all the details are visible until the required density is obtained. With this developer used in the above proportions there is no danger of fog, except from the action of light.

If, on the application of the mixed developer, the image flashes out and the details in the shadows appear too quickly, it will indicate that the plate has been over-exposed; therefore at once throw off the mixed developer, and, without stopping to wash the plate, flood it with D alone, when the development will be checked, and will proceed more slowly, while the image gains in density; if too slowly, or the negative appears to be getting too intense, add a very little of A. There will, however, usually be sufficient of the latter left on the plate to complete the development with the simple addition of a sufficient quantity of solution D. A very little experience will enable the operator to produce a good printing negative from a plate which, if developed with the full proportion of A, would have been utterly useless from over-exposure. In very warm, bright weather, it will, perhaps, be found an advantage to use rather more D than A in the mixed developer, giving just sufficient

exposure to avoid hardness in the negative. Under-exposure can be corrected to a great extent by increasing the proportions of A in the mixed developer, but the addition should be made at once before the development has proceeded too far, or the effect will be to increase the density, and cause too much contrast in the negative.

These concentrated stock solutions will be found very convenient to use, and a great saving of time in weighing and measuring small quantities.

With regard to the keeping properties of the No. 1 pyrogallic solution, Mr. Edwards stated—and the writer can confirm it—that no difficulty is found whatever; the glycerine seems to act as a perfect preservative.

CHAPTER V.

BENNETT'S GELATINO-BROMIDE PROCESS.

THE next process we shall describe is that brought out by Mr. C. Bennett, and was the first process published which gave extreme rapidity. The description of it is extracted from the *British Journal of Photography* in his own words, as much stress is laid on following strictly the directions laid down. Mr. Bennett says :—

"First, then, the light. I have tried 'warranted non-actinic,' and 'tested by spectrum analysis' glass, and can print transparencies through two thicknesses of such in about thirty minutes. Procure, therefore, from a glass merchant, some of the *darkest* shade of ruby, and use two thicknesses for daylight, and one for lantern. This is positively necessary, as we are to use a very powerful developer upon a very sensitive plate. If gelatine workers were careful on this point I think we should hear less of 'organifiers' or 'want of density' than at present. I never have any trouble on that score, because no actinic light having touched the emulsion I can apply any amount of development without any danger of fog.

"To make 'assurance doubly sure,' use a ruby-coloured hock bottle, and with two eight-ounce decanter-shaped bottles made of test-tube glass to stand heat—procurable at Rouch's, and, doubtless, elsewhere—weigh out for a ten-ounce solution—

Ammonium bromide	...	...	70 grains
Best silver nitrate	...	...	110 "
Gelatine...	...	...	200 "
Distilled water ...	...	...	6 ounces

Use Nelson's 'No. 1 photographic gelatine,' for with the opaque sixpenny packets you have irregularity, red fog, and frilling. Place aside four ounces of water for the bromide, and two ounces for the silver; dissolve the bromide with heat in one of the test bottles in one or one and a-half ounces of water; pour into the hock bottle; swill out the test tube with the remainder of the four ounces set aside for the bromide, and also pour in. I do it by heat to ensure all being dissolved, as it does so very slowly after the gelatine is inserted. The four ounces of solution being now almost cold, add the gelatine, shake up well, and place in two or three gallons of water at 90°. I use a fish-kettle with lid. [A good-sized saucepan with a lid answered perfectly with the writer.] In two hours the bromized gelatine will, after well shaking, be quite liquid, and also nearly at 90°. Now dissolve the silver in the other test bottle by heat in one ounce of water, cool to 90°, and pour in; use the remainder of the two ounces set aside for the silver to swill out, heat to 90°, and pour in. By being so particular we get regularity, and are able to mix the plates of different batches, which is a great boon. Shake the

emulsion very briskly, and replace in the kettle for two, four, or seven days, according to rapidity required. The temperature should never be over 90°; if you do not let it exceed that you will not have red fog. 'Cosy' it up with flannel, and it will not lower many degrees during the night. I, however, use a stove two feet across, and place it on that; a faint gas jet below keeps it always at 90°. I shake up every twelve hours. If washed in two days, the emulsion is rapid and dense; in four days more rapid and less dense—quick enough for any drop-shutter known, when developed as below. With some that I kept for seven days, with drop shutter on a dull February morning, pebbles close to the camera were perfectly exposed. The negative was thin under ammonia, but bore intensifying to any extent.

"Cool the emulsion in a bottle not smaller than a Winchester quart, and wrap it up in brown paper to exclude all light except the lip of the neck. Let an india-rubber tube go quite to the bottom of the bottle to stir away those layers of water which, on account of greater specific gravity (by reason of the salts they now contain), would otherwise remain there. Wash for twelve hours; a dribble is sufficient. Upon melting you have eight or nine ounces of emulsion; add three-quarters of an ounce of pure alcohol heated to 90°; fill up with water (also warm) to ten ounces, and coat. The plates should be only lukewarm, or you will have red fog. For beginners it much helps the coating to double the quantity of alcohol, leaving out water to that extent. The operator should not be alarmed at the peculiar mottling of the film (due to the alcohol), directly after coating; this subsides in a few seconds to an even surface. The

extra alcohol does not appear to alter the sensitiveness, and is a great help; but with experienced workers it is not necessary, and the quantity is sufficient to draw the emulsion up to the edges, which is the sole object of introducing it. When no alcohol is used you always have *thin* edges, which is very objectionable, as the negative, of course, will print dark at those parts, and this small addition of alcohol totally rectifies this fault. It is difficult to measure the exact quantity of emulsion required for each plate; one ounce would probably cover *eight* plates of $6\frac{1}{2}$ by $4\frac{3}{4}$ size.

"By darkening a good-sized room temporarily for coating, it obviates the necessity of a drying-box, for if the films can lie on the table for twelve hours, they will be dry, or sufficiently so to stack up in an ordinary box. Expose a few plates with small stops—instantaneously; gradually increase the size of stop or length of time.

"To develop, I use, for $6\frac{1}{2}$ by $4\frac{3}{4}$, one ebonite tray $8\frac{1}{2}$ by $6\frac{1}{2}$ for ammonia, one ditto for silver, and one 10 by 8 to cover over either during development to keep all light off. After soaking a minute, pour the following quickly along that side of the tray which is not occupied by the plate, and by rocking the dish suddenly send it sweeping over the plate (it is developed in five to twenty seconds):—

Pyrogallic acid	1 grain
Bromide	*none*
Pure undiluted liquid ammonia	1 to 10 drops
Water	1 ounce

Do not flood with pyrogallic acid first, or you will render

the plate slower; nor add more pyro, or you will again slow the plate, and, moreover, have it too dense. If the exposure has been sufficiently short, you should have a dense negative, with bare glass for shadows, almost as soon as the developer has covered it. A 10 by 8 Dallmeyer triplet, with drop-shutter, would require in good light (say) four drops of ammonia; if bad light, eight to ten drops. A six-inch single lens, in good light would require (say) one drop; in bad light, four drops. It much ammonia be used, and the plate be not developed in half a minute, make fresh developer, and wash the plate.

"Being now in possession of some extra-sensitive plates, put one in a thick book, and, having placed it five or six inches from your ruby glass window or lantern, draw out the plate one-third for a few minutes; again draw it out further one-third more for a short period. You will then have the film in three divisions, as it were, one portion not having been exposed to the red light, and the other two portions having had different exposures. Now develop, and use (say) three drops of ammonia. If your light be still at fault, the exposed portions of the plate will fog; in that case, use another thickness of ruby glass."

CHAPTER VI.

GELATINO-BROMIDE EMULSION MADE WITH GLYCERINE.

THE next emulsion is one described in the *Photographic News* by the writer. It is a method of preparing an emulsion by adding *washed* silver bromide to gelatine.

Let us suppose we are going to make up about 7 ounces of gelatine emulsion. Weigh out ammonium bromide, 100 grains (or its *equivalent* in zinc, potassium, or any other bromide), and dissolve in 20 ounces of water (not necessarily distilled water). Next weigh out 180 grains of silver nitrate, and dissolve in 6 ounces of water, and add 6 drachms of glycerine to it, and stir thoroughly with a glass rod. I prefer to put this mixture in a glass jar holding about 40 ounces (an empty French prune bottle would answer every purpose).

The bromide solution should now be added very cautiously. Take a 10-ounce measure, and fill it up to six ounces, or thereabouts, so that it is not too full, and gradually drop, little by little, the solution into the silver solution, stirring very thoroughly the whole time. A milky emulsion forms, and gets thicker and thicker

till the whole bromide in the 20 ounces is added, though, of course, the fluid is *per se* thinner; a quarter of an ounce of nitric acid is next added, and well stirred up. This addition is made to save any chance of fog, which might be caused by the excess of silver present, the reason of which I have already described in other works, and need not repeat in a practical description of a process.

This emulsification is better carried on in a dark room, though it is not absolutely necessary. Here let me remark that the bromide solution must be poured into the silver solution, and not *vice versa*, or a failure will be most probable. The glass jar and its contents may now be placed away into a cupboard, and left for as long a time as is convenient, but not for less than a quarter of an hour. By the latter time the silver bromide will have fallen to the bottom of the jar, with the exception of a very *slight* milkiness, which will subside in a couple of hours. The silver bromide, however, left in suspension at the end of the quarter of an hour is so small that it may be decanted off without detriment to the emulsion, and with infinitesimal lightening of the pocket. The jar may be tilted, and the liquid poured off, or a syphon may be introduced (and this is a neater way), and the liquid syphoned off close to the precipitate. About 20 ounces of water are again poured into the jar, the precipitate *well* stirred up, and again allowed to subside. As soon as ever the subsidence takes place, the water is again decanted or syphoned off. This operation is repeated four or five times, after which the decanted water may be tested for acidity, and for silver nitrate.

To try for the former I hold moistened litmus paper over an open ammonia bottle till it is thoroughly blue, wash it well in distilled water, and then throw the washed paper into the decanted water. The faintest trace of acid will redden it. If it does turn red, the washing must be repeated. Let us pause for a moment, and see, after five washings, what amount of acid would be present, even suppose we left an ounce of water behind after each decantation. Six drachms of acid were originally added to about 27 ounces of water. In each ounce, therefore, there could be 6-27ths or 2-9ths of a drachm of acid left. The fluid is, after decanting 22 ounces, made up to 20 ounces, and each ounce will contain one-twentieth of 2-9ths drachms of acid, or 1-90th of a drachm; continuing the calculation in the same way after the third washing, there will be 1-1,800th of a drachm; after the fourth, 1-36,000th of a drachm; and after the fifth, 1-720,000th of a drachm, an amount almost inappreciable. To test for free silver nitrate, add to the wash water 1 drop of potassium chromate. A red colouration indicates the presence of silver nitrate. In case of the presence of either one or the other, as is shown by the litmus paper and the chromate, the washing must be continued till they are completely eliminated.

The next part of the process has now to be taken in hand. 100 grains of gelatine are soaked in 2 ounces of water (the gelatine most suitable is Nelson's "No. 1 photographic gelatine"), and another 100 grains of harder gelatine (such as Coignet's gold medal gelatine) in 3 ounces of water. The vessels containing both these (after the gelatine is properly swelled) are placed in warm water of about 100° Fahr., which will gradually dissolve

up the glutinous masses. This effected, the smaller lot is placed in a wide-mouthed bottle capable of holding about twenty ounces of fluid, and the washed silver bromide added to it. The mouth of the bottle is then closed by a cork or bung, and the contents well shaken up until it becomes a froth. It is next placed in a kettle or saucepan containing warm water of about 100° Fah., and the latter is held over a Bunsen burner or spirit lamp to keep up the temperature. When the froth has subsided the bottle is again shaken and the warming process repeated. After two or three such shakings a little of the gelatine emulsion may be dropped upon a glass plate, and examined for granularity. If absent, so much the better; but if present, half the second lot of dissolved gelatine must be added, and the shaking repeated.

We now come to a part of the process about which opinions differ. My own idea is that the emulsion may be raised to boiling point without damage; others contend that this gives rise to frilling—I think not, myself. It may be raised two or three times to boiling point, and I have not found the plates prepared with the emulsion have any more tendency to frill than others prepared with an emulsion which has been worked at a low temperature for days. If the emulsion be raised to boiling for five minutes, then shaken, and the same operation repeated a second time, I believe that you have an emulsion which is as rapid as any to be obtained by the more fatiguing method. At any rate, this plan will give as smooth an emulsion as any other method, provided the operator's fingers are not all thumbs when the bromide is dropped into the silver.

When the emulsion is ready, the remainder of the

gelatine solution not already added should be poured into the bottle, together with half an ounce of alcohol, and after a final shake, and filtering through washed cotton wool, it is ready for coating the plate.

It is difficult to emulsify silver bromo-iodide in this way, and the more tedious method of washing should be resorted to if any iodide be present.

CHAPTER VII.

DR. VAN MONCKHOVEN'S PROCESSES.

1*st Process.*—Dr. Van Monckhoven, in trying the writer's original plan of washing the silver bromide before adding it to the gelatine failed, but hit on the following ingenious methods, which are given in his own words:—

"I prepare very pure and dilute hydrobromic acid, and I determine accurately the amount of it required to precipitate exactly 150 grains of silver nitrate. I then dissolve this quantity of acid in 7 ounces of water, with which I incorporate, by heating, 40 grains of gelatine. On the other part—and from this moment I entirely operate in the dark room—I precipitate 150 grains of silver nitrate by a very slight excess of bicarbonate of soda; I let it settle for twenty-four hours, and then renew the water to the same amount, after which I let it settle again previous to decanting. On this precipitate of silver carbonate I pour a hot solution of 30 grains of gelatine in 7 ounces of water. This is well stirred, and then I pour on it the solution of gelatine and hydrobromic acid. The mixture is thoroughly shaken every quarter of an

hour, and is kept at the constant temperature of 120° Fahr. The silver carbonate dissolves slowly in the hydrobromic acid, and the silver bromide is formed in the colloidal liquid in a state of extreme sub-division. At the end of ten or twelve hours the mixture, when flowed over glass plates, has a greenish white colour. I next introduce 150 grains of gelatine, cut into very thin shreds, which I dissolve by stirring, and then, without washing the emulsion, I flow it over the glass plate.

"In order to obtain a success with this method it is necessary to take some precaution. The hydrobromic acid must be free from phosphorus and sulphur; the water used for washing the silver carbonate must contain no trace of carbonic acid.

"In an emulsion prepared by this method there is always an excess of hydrobromic acid and of silver carbonate, but I have satisfied myself by other experiments that the presence of these substances does not affect the results. This is not the case if carbonate be replaced by the oxide of silver; the emulsion is then grey, and gives rise to fogging. The plates that I have prepared by this method are twenty times as rapid as the best wet collodion, and, compared with the best English plates, I have found them to be three or four times as rapid. For the rest, the same observations and the same methods apply also to collodio-bromide."

2nd Process.—Dr. Van Monckhoven's second process is as follows:—

"Procure some of Nelson's No. 1 photographic gelatine. I insist upon this point, because you will not succeed with German or French gelatines, which are prepared in a different manner from those of Nelson.

Weigh up exactly 153 grains of this gelatine and 122 grains of pure and well-dried ammonium bromide. Put these two substances into a bottle, and pour upon them 10 ounces of distilled water. In a quarter of an hour the gelatine will have swollen, and you can now put the bottle into a warm water bath and agitate in order to dissolve the two substances.

"Weigh out 184 grains of silver nitrate, and dissolve in 1¾ ounces of distilled water. Now pour the silver emulsion into the bottle containing the bromide, a little at a time, well shaking it after every addition. When all the silver solution has been added, pour in 1 drachm of pure ammonia of a density of ·880, and shake up well the solution. The ammonia exercises quite a special action here; its effect is to render the emulsion ready to be used in a few minutes, or, if great sensitiveness be required, it can be obtained in a few hours instead of days, and thus decomposition of the gelatine is avoided.

"Now pour the solution of gelatine into a porcelain dish, and place it upon cold water and let it set. When set, detach it from the dish, place it in a strong linen sack, and wring it so that the gelatine is expelled in shreds, which are easily washed through a fine sieve. A washing of five hours in water three times changed suffices. Collect the pellicle on a clean linen cloth, and dissolve it at a temperature of 35° Centigrade, and it is fit for use. This process is a combination of those of Mr. Bennett and Messrs. Wratten and Wainwright, with this difference—that I add the ammonia in order to have the emulsion ready to work in a few hours instead of days."

CHAPTER VIII.

PREPARATION OF RAPID GELATINO-BROMIDE PLATES WITHOUT IODIDE.

The light for the preparation and development of these plates must be much more subdued than that given at page 21. In fact, the minimum of light should be used, the quality of it being that recommended by Mr. Bennett (page 34). A very excellent emulsion may be made by following the directions given at page 20, omitting the iodide. The formula will then stand thus—

Ammonium bromide	120 grains
Nelson's No. 1 photographic gelatine	25 grains
Water	1½ ounce
Silver nitrate	200 grains
Water	1½ ounce

The directions for making and boiling the emulsion, coating the plates, and development, are precisely similar to those given in detail in Chapter IV. The rapidity of these plates is extreme, being some twenty times that of a wet plate.

CHAPTER IX.

PREPARATION OF AN EMULSION OF MEDIUM SENSITIVENESS.

It is sometimes a desideratum to have plates which are not so rapid as those prepared by the foregoing methods. The following is taken from Mr. Kennett's directions, with a slight modification, and when prepared with this emulsion the plates are two or three times more rapid than by the wet process: 20 grains of Nelson's No. 1 photographic gelatine and 20 grains of Coignet's gold medal gelatine are placed in one ounce of water in which 30 grains of potassium bromide have been dissolved. It is then warmed by placing the jar or glass beaker containing it in hot water, till the gelatine is dissolved; 40 grains of silver nitrate are next dissolved in another half-ounce of water, being warmed up to a temperature of 100° Fah. This is added to the bromized gelatine with stirring (see page 23), and, after standing half-an-hour, it is poured into a flat dish to set. When well set, it is covered with water, and allowed to stand an hour, and is then broken up into lumps, and washed as given at pages 25 and 52. The plate may be coated after the addition of half a

drachm of alcohol, and after filtering through washed cotton wool or chamois leather (see page 27). The exposure required must be ascertained by comparison with a wet plate. The plates may be developed by any of the methods given at pages 29 to 32, and 57 to 59. For the security of the film it may be advisable to add one-eighth of a grain of chrome alum dissolved in one drachm of water to the above quantity of emulsion.

CHAPTER X.

VARIATIONS IN THE MANIPULATIONS WHEN PREPARING AN EMULSION.

In Chapter IV. we have given a mode of mixing the gelatine and bromide with the silver nitrate, but there are various modifications in this and other operations which have been adopted by workers, and it is proposed in this chapter to mention a few of them. Now as to forming the emulsion, Mr. England finds that if two drachm measures be filled, one with the bromide solution, and the other with the silver nitrate solution, and then be poured into a bottle together and well shaken, and this operation be repeated again and again till the two solutions are exhausted, he gets a perfect emulsion without grain and very smooth. It will be noticed that in this plan the silver and the bromide solutions should be in equal quantities. Another plan, adopted by Mr. Warnerke (whether it is original with him is not of great consequence) is to draw out two funnels to fine points, and support them on funnel-holders over a jar. These are filled with the two solutions, which are allowed to run into the jar, a stirrer being used to aid emulsifica-

tion; other workers use the scent-diffuser, by which to secure fineness of grain. Any of these artifices may be employed.

Another Mode of Emulsifying the Silver Iodide is to omit the soluble iodide from the soluble bromide in the first instance, and to dissolve it in (say) one drachm of water; when half the silver nitrate has been added to the bromide the iodine is dropped in with stirring, and the remainder of the silver solution subsequently added. This is an excellent plan, and depends for its value on the fact that the iodine from the iodide will replace the bromine from the silver bromide, soluble bromide being reformed. The grains of silver iodide thus formed have the same size as the bromide originally formed.

A good Stirring-rod may be made by taking a glass rod, and tying across it with clean string a strip of glass about a couple of inches long and half an inch wide. This cross-piece effectually stirs up the emulsion during its formation by a motion of the rod between the first finger and thumb. We recommend its use.

Modes of Washing the Emulsion.—There are several modes of washing the emulsion besides that given at page 24. Putting on one side dialysis as introduced by Mr. King, owing to its tediousness, we pass on to the most ordinary method. The emulsion when prepared is poured out into a flat dish in a very thin layer (say) of about $\frac{1}{8}$ of an inch thick. When set, it is scraped off the dish with a piece of glass and transferred to a jar or bottle in strips. Cold water is then poured on to it, and a stream of running water kept flowing over it for twelve hours, more or less.

The writer has converted a tin canister into an effective

washing apparatus, as shown in the figure. In the lid of a common canister a hole is perforated so as just to admit of the insertion of a glass tube *a*, *a*; a piece of india-rubber tubing connects this with the water tap, and covers

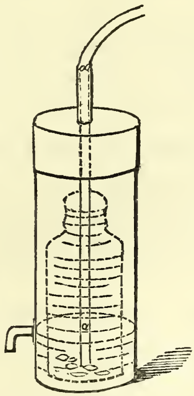

Fig. 8.

any small chink between the glass and the lid, as shown. A spout is soldered on to the canister, as shown. A bottle containing the emulsion to be washed is placed in the canister, the tube being inserted in it. The water flows over the top of the bottle, and rises in the canister to the level of the spout, where it trickles over into the sink; the heavy water containing the soluble nitrate is thus perpetually stirred up and caused to flow over the neck of the bottle. This answers admirably, and can be used in the daylight, if necessary. A combination of this method with that given on page 24 can be efficaciously made, only once squeezing the emulsion through the napless canvas.

Another method is also due to Messrs. Wratten and

Wainwright, and is as follows:—After the emulsion has been allowed to rest for two or three hours, two ounces of alcohol to each ounce of water used are poured into the bottle containing it, and well shaken up. The gelatine rapidly assumes a pasty appearance, and subsides to the bottom. The bottle is then inverted, and the fluid, which contains the soluble nitrates and excess of water, is poured off and may be preserved for distillation. The explanation of the efficacy of this method is, that the alcohol has a greater affinity for water than has the gelatine, and that in extracting the water the soluble salts are extracted with it. Methylated spirit not containing gum may be used, and the lower the specific gravity the more effectual it is.

Draining the Emulsion.—It will sometimes happen that no amount of draining over a hair sieve or canvas (see page 26) will render the emulsion sufficiently free from water to set well when dissolved up. We have found that by pouring a couple of ounces of alcohol through the emulsion when draining that the excess of water is taken up, and it becomes firm. It should be noted that before redissolving the gelatine it should be firm and free from all sloppiness (if such an expression may be used), and one dose of alcohol effects this, and if not one, two will. The alcohol may be saved if required. In case this artifice be resorted to, only half the quantity of alcohol should be added to the emulsion, when it is redissolved for filtering and coating the plates.

CHAPTER XI.

DEVELOPERS.

At pages 29 to 33 the methods of mixing and using some developers have been given, and in this chapter one or two other formulæ will be given.

Concentrated Ferrous Oxalate Developer.—To prepare this developer *ab initio*, the solid ferrous oxalate must be made, though it can be purchased almost as cheaply as it can be manufactured. The first solution to make up is—

Ferrous sulphate ... a saturated solution

Next add to it sufficient oxalic acid (a saturated solution) to cause all the iron to be precipitated as ferrous oxalate, which is of a bright lemon colour, and very heavy, sinking rapidly to the bottom of the vessel.

The ferrous oxalate must, of course, be washed, and, since it is heavy, this can be readily accomplished by the method of decantation. The supernatant fluid is carefully poured off, and the vessel is then filled with fresh water (tap water will answer), which, after well stirring, is poured off, and the vessel filled up again. This washing may be considered to be complete after six changes of water.

A saturated solution of the neutral potassium oxalate is next required, and this can be prepared by adding a saturated solution of caustic potash to a saturated solution of oxalic acid, till a very faint blue colouration is given to red litmus paper. A crystal of oxalic acid is then added, and the neutral solution will be formed. This is concentrated by evaporation until such time that, on cooling, crystallization begins to take place.

The ferrous oxalate is next thrown into the warm potassium oxalate solution; only so much of the oxalate being added as to leave a slight portion of the ferrous compound undissolved. The solution will be of a deep red colour, and, when cold, should be filtered free of all deposit. It is then ready for use.

If the ferrous oxalate and neutral potassium oxalate be purchased, it is only necessary to make a saturated solution of the latter, warm, and then add sufficient ferrous oxalate to leave a slight precipitate. After cooling and filtering, a little more solution of potassium oxalate should be added—say one-twelfth of the bulk of the developer.

The ferrous oxalate solution rapidly oxidizes by contact with the air, as already hinted at, and our own practice is to fill 4-ounce bottles with it, cork them up, and then to lute the corks with paraffine. Mr. Warnerke has a still better plan. He uses a stoppered bottle having an opening near the bottom, such as can be procured at any chemical dealer's. Into this opening he fits a cork carrying a small glass tube; on to the end of this (outside the bottle, of course) he fits a piece of india-rubber tubing, and connects this with a similar piece of bent glass tubing, which reaches nearly as high as the top of the bottle. He fills the bottle two-thirds way up with the

ferrous oxalate solution, and then pours in a layer of paraffine. This prevents any access of air to the solution. To get at the solution, the bent tube is turned down below the level of the paraffine, and the developing cup or bottle filled.

Mr. F. York gives the following formula for preparing ferrous oxalate developer :—

No. 1.

Ferrous sulphate	... ...	160 grains
Water	... ...	1 ounce

No. 2.

Potassium oxalate (neutral)	...	1 ounce
Water	... ...	3 ounces

This makes up 4 ounces of developer, and by using these quantities saturated solutions are obtained.

Another form of alkaline developer can be made as follows :—

P.—Pyrogallic acid	... *3 to	4 grains
Water	... ...	1 ounce.
A.—Ammonium bromide	... ...	120 grains
Ammonia ·880	... ...	½ ounce
Water	... ...	16 ounces.

Equal parts of P and A are used; the proportions may be modified as indicated at page 33, to suit the nature of the image.

* It must be recollected that the more pyrogallic acid used the greater the density, and the more liability to stop development.

Another plan of using the alkaline developer is as follows :—

No. 1.

Pyrogallic acid ...	... 100	grains
Alcohol	... 1	ounce.

No. 2.

Ammonium bromide ...	... 180	grains
Water	... 1	ounce.

No. 3.

Ammonia ·880 ...	... ¼	ounce
Water	... 3¼	„

One ounce of water is taken, and 10 drops of No. 2 and No. 3 are added to it, and flowed over the plate in a dish; 5 to 10 drops of No. 1 are then dropped into the cup, and the fluid poured on to it. The whole is then poured over the plate, and development commences. The separation of the ammonia from the bromide solution is useful, since if the image appears slowly more ammonia can be added; if too quickly, more of No. 2; and if density seems lacking, more of No. 1.

Mr. William Bedford gives the following formulæ. It will be observed that nitric acid is used with No. 1, the effect of which is to keep the pyrogallic acid from discolouring :—

No. 1.

Pyrogallic acid... ...	... 60	grains
Nitric acid	... 8	minims
Water	... 20	ounces.

No. 2.

Ammonia ·880	2 drachms
Ammonium bromide	75 grains
Water	20 ounces.

These two solutions will keep good for a considerable time, and should be mixed, immediately before flowing over the plate, in equal parts, or the proportions may be varied to suit the exposure.

CHAPTER XII.

INTENSIFYING, FIXING, AND VARNISHING GELATINE NEGATIVES.

This part of the gelatino-bromide process is one which has to be touched upon with the very greatest care, since all methods of giving intensity have as yet to stand the test of time. Now, as a rule, a gelatine negative has to be intensified *after* fixing, since the opacity of the film is usually so great that the operator is unaware what density his negative has taken under development. The great desideratum is a good silver intensifier, but this is fraught with so many dangers that great precautions must be taken to ensure success. It may be laid down as an axiom, that to be successful the whole of the hyposulphite of soda and silver must be eliminated from the film, and where the film is of any thickness this is by no means a matter taking a short time. The writer has been experimenting some time on this, and finds that at last he has hit on a successful plan. After the green tint of the unacted-upon salt has disappeared, the plate should be placed in fresh hyposulphite, and kept there a short time. This being

done, the plate had better be kept in water for an hour or more, the water being changed at intervals. After this, the gelatine film may be made more secure by applying to it a solution of *peroxide of hydrogen* in water. A drachm of what is called a 20-volume solution to 5 ounces of water is sufficient. When it has soaked in this for ten minutes, it is again washed, and intensification can commence. Those who may have endeavoured to intensify with pyrogallic acid and silver (see "Miscellaneous Notes") a negative treated in the ordinary way will find that red stains occur almost invariably where the film is thickest, that is, where the hyposulphites have not been thoroughly eliminated, and to eliminate them this extra precaution above indicated is necessary. The following is recommended:—

Ferrous sulphate	...	...	5 grains
Citric acid	...	...	...	10 ,,
Water	...	...	...	1 ounce.

To this, one or two drops of a 20-grain solution of silver nitrate are added, and the plate intensified as if it were a wet plate. Now, it by no means follows that a film thus intensified would be free from a liability to change in the presence of light, since the silver might partially combine with the gelatine. After density has been attained, the plate is washed and put in a dish containing common salt, and once more passed into the fixing bath for a few seconds, again washed, and then dried.

Mr. Dudley Radcliffe has slightly modified the above, and he too recognizes the importance of eliminating the hyposulphites. To eliminate them, he places the film, face downwards, in water in a pie-dish, by which the

heavier solution sinks to the bottom. He intensifies with the following:—

Sulphate of iron and ammonia		1 ounce
Lump sugar	... ...	1 "
Glacial acetic acid	... ...	2 ounces
Albumen of	... ...	1 egg
Distilled water	... ...	20 ounces.

The albumen is added after the other ingredients are dissolved.

Success in intensifying by either of these methods the writer has found to be more certain when the ferrous oxalate developer has been used in lieu of the ordinary alkaline developer.

The next intensifiers are the mercury intensifiers, which may be classed as most uncertain in their action and in the permanency of their results. The negative can be intensified either immediately after the washing which follows the fixing, or it can be employed upon a negative which has been dried. In the latter case the negative must be steeped for a minute or two in water. Mr. England recommends the following as giving him what he desires:—

Mercuric chloride (bichloride of mercury	... ...	20 grains
Ammonium chloride	... ...	20 "
Water	... ...	1 ounce

After the negative has been thoroughly washed, the above solution is poured over it till the surface assumes a grey tint. After a thorough wash a weak solution of ammonia (10 drops to 1 ounce of water) is applied till a

dark tone is assumed by a reflected light, and brown by transmitted light. With collodion the intensity thus given is unstable, and the film has a tendency to bleach. The following method of intensifying is recommended by Dr. Van Monckhoven :—

No. 1.

Distilled water	4 ounces
Mercuric bichloride	35 grains
Potassium bromide	35 ,,

No. 2.

Distilled water	4 ounces
Silver nitrate	35 grains
Potassium cyanide, pure and crystallized	35 ,,

In order to make the first solution, the chloride of mercury is put into a mortar and ground up with the water until all is dissolved, and then the bromide of potassium added. To prepare the second solution, the silver nitrate is dissolved in 2 ounces of water, then the cyanide in the other 2 ounces, and the two solutions mixed. A slight precipitate of silver cyanide will be seen at the bottom of the bottle, and must remain. Pure and crystallized potassium cyanide must be used; ordinary cyanide will not answer the purpose.

The negative is placed in No. 1, and left a longer or a shorter space of time according to the intensity required. The extreme limit is attained when the image has become white. After thorough washing it is immersed in No. 2. It must remain only a few seconds if its stay was but short in the bichloride of mercury. If

it had been a long time in that solution, it can remain also a pretty long time in the cyanide solution without danger. At all events, it is necessary that the white produced on the negative by the mercury bath should disappear in the second solution. This can be seen by examining the negative from the back. The negative must not remain too long in the silver cyanide bath, since the latter reacts on the blacks of the image, and takes away a part of their intensity.

The negative is now thoroughly washed and dried without going into the hyposulphite solution again, as this solution would destroy all the intensity obtained. The successive action of the silver cyanide and the bichloride of mercury has for its object to produce a violet chloride of mercury in the blacks of the image. This salt does not change by the action of light.

To Mr. B. J. Edwards, we believe, is due the credit of adding sodium hyposulphite to the mercury intensifier. This formula is as follows :—

No. 1.

Mercuric chloride (bichloride of mercury)	60 grains
Water	6 ounces

No. 2.

Potassium iodide	90 grains
Water	2 ounces

No. 3.

Sodium hyposulphite	120 grains
Water	2 ounces

The iodide solution is poured into the mercury solution,

and then the solution of hyposulphite, which dissolves the iodide of mercury which has been formed.

The negative is fixed and washed, and the plate immersed in the above solution. Mr. Edwards says of it: "The intensifier acts very quickly, a few seconds being sufficient to give printing density to the thinnest negative. If required to work slower, add more hyposulphite, which will also alter and improve the colour of the negative. The shadows remain quite clear, there is no loss of detail, and the colour of the negative is all that can be desired. The negative must finally be well washed."

Varnished negatives may be intensified by removing the varnish first in warm methylated spirit, and, after rinsing under the tap, a tuft of cotton-wool should be applied to the surface. We think that there is but little more to be said regarding intensifying a negative. If it be weak and full of detail, we much prefer to make a thin transparency by contact, and from this another negative also by contact. By this means proper intensity can be given to the reproduced negative, which it is almost impossible to give to the original, so that all the rapidity of the gelatine plates is secured together with the advantage of the collodion film for intensifying. We can strongly recommend this plan to our readers, as it has been most successful in our hands.

Another plan of getting intensity, which is decidedly successful, was one recommended by Mr. Kennett, which is as follows:—

To 3 ounces of water add 1 ounce of sodium hyposulphite, to another 3 ounces add 1 ounce of ferrous sulphate (proto-sulphate of iron), mix, and allow them to stand a short time. When the plate has been well washed after

development, it is placed in this mixture, and the image will be fixed and intensified to an intense black. A great advantage of this fixing solution is that the ferrous sulphate acts on the gelatine as a hardening solution, being even more astringent than alum.

Fixing the Negatives.—The formula for the fixing solution has been given at page 30, and need not be repeated. The strength there noted is perhaps rather great for many commercial plates, and it might be made up to about one ounce of hyposulphite to a pint of water. This diminution in strength is said to reduce the chance of frilling.

Varnishing the Negative.—Before any varnish is applied it is preferable that the film should have a coating of plain collodion. If it has received one to avoid frilling, it will be unnecessary to give it another. When the collodion is set the writer's experience tells him that almost any varnish will answer. Mr. England uses seed lac in methylated spirit, a saturated solution, and then thinned down till it was of a proper consistency. The Autotype Company prepare a special varnish for gelatine plates, as does Mr. Hubbard one to use as a retouching medium. Where many prints are not to be taken, it is believed that the film of collodion alone is a sufficient protection against the silver nitrate of the paper combining with the gelatine, and so causing a discolouration. If a negative does get discoloured through this, a very dilute solution of potassium cyanide will usually clear away any marking that may have been made. But great care must be taken in using this solvent of the silver compound, as it also attacks metallic silver when in such a state of fine division as that in which it is to be found in the gelatine plate.

CHAPTER XIII.

PRECAUTIONS TO BE TAKEN IN HOT WEATHER.

This chapter may be taken as an auxiliary to the preparation of an emulsion, and is to be read with Chapter IV., where the preparation of a bromo-iodide emulsion is described. Up to the operation of boiling, no change need be made in what is therein described; but taking the bromo-iodide emulsion for a text, we propose to show how modifications should be introduced. After the boiling it is stated that 160 grains of gelatine are to be added. Instead of adding this quantity, 40 grains of fine-cut gelatine are kept back, and the remaining 120 grains are soaked and dissolved as far as possible in 1 ounce of water, and added to the boiled emulsion, which is then poured out to set. After the washing operations, and after draining, the other 40 grains of gelatine are added to the dissolved emulsion, immediately before filtering. This gives a greater consistency to the gelatine, and it will not be so difficult to get setting properties. In addition, five or six drops of a half strength solution of salycilic acid is also advisable to prevent decomposition.

When the plates are coated and have to set, the greatest difficulty is then to be encountered, and we have found that *ice* is a very useful adjunct under these circumstances. What we do is this: we place the glass levelling shelf (see page 28) on three blocks of wood at points where the wedges usually are placed, and the wedges on these. By this means dishes containing small lumps of ice can be placed beneath, which thoroughly cools the slab in half an hour. The plates when placed on it are rapidly cooled, and set in a very short time, and can then be transferred to the drying closet. When once thoroughly set there is but little danger of the film melting at any temperature below 100°, as the harder sorts of gelatine take a temperature a good deal above this to be affected. The writer has prepared batches of plates at a temperature of 92° Fahr., which have been every way satisfactory when these precautions have been adopted.

It is also advisable to aid the setting previous to washing of thegelatine emulsion by placing the dish in melting ice.

There is sometimes a difficulty in getting plates to dry *slow* enough in warm weather in England's drying box. Very rapid drying means slow plates, and we have found that placing a couple of trays of water, with a little cotton wool in them or a sponge, has moistened the air sufficiently to prevent this evil.

Regarding the development of the plate, it is advisable to slightly increase the soluble bromide in the alkaline developer, say by about $\frac{1}{6}$, and with the ferrous oxalate, when it would be unretarded in cold weather, one drop of a 30-grain solution of bromide to each ounce should be added when the temperature is over 70° Fahr.

If plates have a tendency to frill at all, they will frill in

hot weather, so the alum bath should be placed in requisition; but it is better still to give every plate before development a coating of plain collodion (see page 72). No matter what strength of sodium hyposulphite, or what normal temperature the water may be, there is an immunity from the evil.

CHAPTER XIV.

FAILURES AND THEIR REMEDIES.

Frilling.—The causes of failure are, in all cases, somewhat too difficult to track to their sources; but we will endeavour to do so as far as possible. The first and greatest nuisance in the gelatino-bromide process is frilling. Frilling is usually caused by the use of unsuitable gelatine, possessing but little tenacity. The more the qualities of gelatine are like glue the less chance there is of meeting with this vexatious evil. If gelatine, however, were like glue in respect to hardness, the difficulty of developing a plate would be very great, since it is too hard. To meet this objection, a certain proportion of a less tenacious gelatine is mixed with the harder kind, a very good index of the tenacity being the temperature at which it melts after swelling. Again, as will be noticed, the addition of chrome alum prevents it to a great extent. Another source of frilling is the plate being unsuitably cleaned. It has been recommended, to prevent any possibllity of the evil, to give the plate a preliminary

coating of gelatine with chrome alum made somewhat after Mr. Henry Cooper's plan. It is as follows :—

Flake gelatine ...	...	...	60 grains
Distilled water...	...	...	3 ounces

The gelatine is first softened, next dissolved; two drachms of a ten-grain solution of chrome alum are added and well stirred in. The plate is first flowed over with this, and as much as possible allowed to drain off, and allowed to dry. This gelatine is perfectly insoluble when cold, and will not leave the plate, except with great difficulty. The gelatine emulsion is used over this; but we recommend the plates to be first soaked in warm water of 100°, and then drained well previous to using it, or the adhesion between the two gelatine surfaces will not be complete.

Another cause of frilling is unequal drying. Thus, if plates be dried in an unventilated box, it will usually be found that a central patch refuses to dry till long after the outsides are completely desiccated. At the junction of this central patch with the neighbouring gelatine frilling is to be looked for. It will spread to the parts which have been the longest in drying. This is due to a false tension set up in the film, and can only be conquered by drying the plate by means of alcohol (see page 29), or by using a proper drying cupboard.

If it be known that a film will frill during development, if precautions are not taken, it can be entirely avoided by using a mixture of half alcohol and half water, in which to dissolve the pyrogallic acid, using four grains to the ounce of mixture, instead of two grains (see page 57). The reason of this extra pyrogallic acid is that the deve-

loper turns black sooner in consequence of using the alcohol.

Frilling usually takes place in the fixing bath, or in washing after fixing. If due to the fixing bath, it *may* be avoided by using a very weak solution of hyposulphite of soda, by the employment of an alum bath before immersion in it, or by using the solution of ferrous sulphate with the hyposulphite (see page 65). The use of methylated spirit with the hyposulphite is likewise a perfect cure at this stage. This generally saves a film which goes through the fixing without frilling; some do so during the washing.

When washing after fixing, frilling is often caused by allowing a stream of water from the tap to impinge on the plate. This should never be allowed, if the film is at all delicate.

Gelatine that has been cooked for a long time has a special tendency to frill, and, unless fresh gelatine be added to the emulsion, in some cases the frilling is inevitable. Long cooking (in warm weather particularly) means decomposition of the gelatine, and decomposed gelatine is perfectly useless for preparing a dry plate. Boiling for a short time has much the same effect as cooking at a lower temperature on the gelatine; hence, to avoid frilling it is better on the whole not to boil the emulsion with the full amount of gelatine. The writer has recently found *that any film, whatever its tendency to frill, may be made completely safe from this evil*, by, previous to developing, coating it with a normal collodion (about 5 grains of pyroxyline to 1 ounce of equal parts of ether and alcohol) and washing the film under the tap. The developer is then applied as usual. The image develops

in the ordinary manner. No frilling can take place, and if there be any tendency to do so it is exhibited by the film curling up. In our own practice now, when we have plates about which we are not sure, we invariably give this preliminary coating.

Blisters on the Film.—Blisters on a film are the usual preliminaries to frilling. When they commence, further damage may usually be avoided by flooding the plate with methylated spirit. This extracts the water, and with it any soluble salt that may be left, and the plate speedily dries, which is an advantage if it be fixed. Blisters are usually found to follow the rubbing marks of the polishing cloth, if such be used. The cure here is self-evident. They also are to be found in places between which the film has dried quickly and slowly.

Red Fog.—The writer fortunately knows very little about this disaster, but it is found to occur if the silver nitrate is in excess of the salts with which it should combine. Even in this case red fog is not known where ferrous oxalate is employed.

Green Fog.—This fog is sometimes met with; it is usually green by reflected light, and slightly pink by transmitted light, being what we may term dichroic. This at once points to the fact that this fog is somewhat of the nature of a dye, and every oxidizing agent ought to destroy it. In some cases we have immersed the film in a strong solution of bichromate of potash, and afterwards washing, the fog has disappeared; but whether it is a certain cure, we hesitate to say; it is, at any rate, worth trying. Peroxide of hydrogen will get rid of it at once.

General Fog.—By general fog we mean the fog pro-

duced during development, and is caused by the partial reduction of the silver salt all over the film. This is probably due to the decomposition of the gelatine by long cooking, the products of which in the presence of a developer are apt to react on the silver salt, and produce a partial reduction in it. The production of this kind of fog, and electrical disturbance in the atmosphere, are apt to go together. In unfavourable weather, a few drops of a saturated solution of salycic acid should be added to the gelatine during boiling or prolonged emulsification; this will generally check or entirely prevent the decomposition. An excess of silver is likewise very likely to produce the evil, but the presence of iodide in the emulsion will almost certainly cure it. Another fruitful source of fog is the light admitted to the plates during preparation or development. The light should be tested by putting a plate in the dark slide, and drawing up half the front, and exposing the half plate to the light for ten minutes. If the fog be due to this cause, the plate on development is sure to show it by an increased reduction of metallic silver in the part so exposed.

Whatever may be the cause of fog—whether the emulsion itself be in fault, or whether the plates have seen light—we have found that, as in the collodio-bromide process, there is one certain sure cure. If the emulsion be at fault, squeeze it into water (see page 25) containing 10 grains of potassium bichromate to each ounce, and allow it to rest for an hour, and then wash again for a couple of hours more. If all the bichromate be not taken out by this washing, it is not of much consequence, since when dry it is inactive. The sensitiveness after this treatment is not diminished, and the negatives taken

with it are beautifully bright. Plates may be treated in precisely the same manner, and give unveiled pictures There is a *slight* diminution of sensitiveness if the bichromate be not at all washed out, but nothing to hurt except where very great rapidity is required.

Flatness of Image is usually due to over-exposure and development with the alkaline developer: the use of ferrous oxalate mitigates the evil, whilst, if iodide be in the film, we have never found any great lack of density to arise. Feebleness of the image is also often caused by too thin a coating of emulsion. In our own experience, a thick film is a desideratum giving all the necessary density to the image, with facility. Remember that when a vigorous image is required, it may easily be obtained by using a *freshly prepared* and strong ferrous oxalate solution (see page 55).

Too Great Density of Image is sometimes met with, and can be remedied by applying ferric chloride to the film, and then subsequently immersing in the hyposulphite of soda fixing bath.

The formula recommended is—

Ferric chloride	1 drachm
Water	4 ounces

This is flowed over the plate a short time, and then, after washing, the plate is immersed in the fixing bath. The solution acts very vigorously and should be diluted if only a small reduction is required. Local reduction may be effected by using a paint brush charged with this solution on the moistened film. This practice is not, however, much to be commended, as it is rather working in the dark.

Yellow Stains.—Sometimes a yellowish veil appears to dim the brightness of the shadows, when the development ment has been effected by the alkaline developer. This may be removed, if thought requisite, by the application of one or two drops of hydrochloric acid to an ounce of water, and floating it over the surface of the plate. The film must be washed almost immediately, as an acid is apt to cause frilling.

Too Granular an Emulsion is usually due to bad mixing of the soluble bromide and the silver nitrate, but it may also be caused by over boiling, and also by too small a quantity of gelatine in the boiling operation. Digesting too long with ammonia, as in Van Monckhoven's process, has the same effect. There is no cure for this evil.

Opaque Spots on a plate are almost invariably due to dust settling on the film when drying; they also may be due to imperfect filtering of the emulsion.

Semi-transparent Spots on the plate before development are generally due to (1st) unevenness of the glass plate, or (2nd) to the use of gelatine containing grease. See page 78 for cure.

Dull Spots on the Negative are due to the use of gelatine which contains greasy matter.

CHAPTER XV.

MISCELLANEOUS NOTES.

Recovery of Residues.—The residues from gelatine emulsions may be recovered by two methods. First by adding 1-10th part of its bulk of a saturated solution of caustic potash or soda, and then boiling. This precipitates the silver in the metallic state, and kills the viscosity of the gelatine. The solution eventually becomes colourless, and the black deposit left contains all the metallic silver. This may be dried, burnt slightly at a red heat and treated with nitric acid, and fresh silver nitrate procured, or it may be added direct to the other residues (old films whether of collodion or gelatine may be similarly treated).

The second method is to add one drachm of hydrochloric acid to each ten ounces of emulsion and to boil. The acid destroys the gelatine, and the silver bromide and iodide precipitate at the bottom of the glazed saucepan or vessel in which it may have been boiled. After decanting the supernatant fluid, the precipitate is added to the residues for reduction.

Clarification of Gelatine.—As has already been pointed out on page 17, certain gelatines are apt to contain grease, and that so tightly that soaking in ether, or washing with ammonia, will not eliminate it. A specific is as follows: We will suppose that 80 grains of Coignet's gelatine are required, 90 grains are weighed out, soaked in water, drained, and melted. The liquid is then very slowly poured, almost drop by drop, into methylated spirit, free from rising (see below), where it is precipitated in shreds of a white pasty character; after it is all precipitated the spirit is poured off, and a slight rinse with fresh spirit given, and then it is covered with water, in which it should remain till the whiteness disappears. The water should then be changed, and the gelatine drained and re-dissolved; about 10 grains out of the 90 seem to be dissolved in the mixture of alcohol and water. Emulsions made with this gelatine will be markedly free from grease spots (see page 76). The same method may be adopted for large quantities of gelatine, omitting the washing away of the spirit, and leaving it to dry spontaneously. This is best done on glazed dishes. The gelatine can be broken up, weighed, and swilled in the usual manner.

Light during the Development of a Negative.—When once the image on a negative has commenced to appear, the light in the developing room may be much increased and even white light will not cause fog (always supposing the dish in which the development takes place is an opaque one) so long as the developing solution is on it.

Sensitometers.—A very useful piece of apparatus has been introduced by Mr. Warnerke for testing dry plates. It consists of a piece of glass covered with squares of

different thicknesses of pigmented gelatine, each square carrying a number which corresponds to the thickness. If a plate be exposed for (say) ten seconds to a gas light at six feet distance, it will show on development a certain number. Another plate is exposed for the same time, and at the same distance may show another. These numbers when read on a scale will show the relative sensitiveness of the two plates. By using a pair of these sensitometers, experiments on developers can be well undertaken.

Gelatine tissue.—Mr. Warnerke has quite recently perfected a gelatine tissue on paper, the results of which are highly satisfactory. The gelatine emulsion is spread on specially prepared paper, on which it is exposed and developed. A very simple application of turpentine loosens the paper and leaves a perfectly transparent gelatine film. In the negatives we have seen produced by this process there is no sign of halation, and the greatest latitude in exposure is admisable, and the images possess that "plucky" character which characterises the wet process. When the photographic public shall have the advantage of obtaining this tissue, the weight of glass plates will be entirely done away with.

Coloured Medium for Windows.—Mr. Warnerke has adopted an admirable material for colouring windows. It is simply the ruby-coloured cloth used by bookbinders. When examined by the spectroscope two thicknesses seemed to do away with every trace of blue, leaving behind merely a band of red. The price is ridiculously low compared with most materials used, and we can recommend it to our readers.

Preparing Ferrous Oxalate by the Cold Method.—In

the chapter on developers a method was given of preparing ferrous oxalate developer by means of a hot solution of potassium oxalate. It may be worthy of remark that by adding to a cold saturated solution of potassium oxalate an excess of ferrous oxalate, an equally strong solution may be obtained. It, however, requires time to give it its full strength. We have used this developer for some time with the greatest satisfaction. The crystallization so apparent in the hot solutions is much mitigated in this case. We hear that the addition of glycerine to any ferrous oxalate solution prevents the formation of any crystals. The writer has no personal knowledge of the fact, but, if it is so, it will be a great boon. He has tried the addition of the glycerine for the purpose of making the ferrous oxalate flow better on the gelatine film, and give a better "bite," and it has proved beneficial.

Safe Mode of Developing a Negative.—In Chapter IV. we have given the method recommended by Mr. Edwards in using his developer, but we think that we may point out another method which is equally effective and very safe, particularly where once exposure is anticipated. Take the proportion given at page 32, of A and D, and dilute with two parts of water to every one part of mixed developing solutions, and the image will appear *very* slowly if properly exposed, slowly if over-exposed. Supposing the former is the case, the solutions are thrown off, and fresh concentrated solutions poured on when the image will attain its proper density, and behave as if the strong solutions had been originally used. If the latter be the case, wait till *nearly* all the detail has appeared by reflected light, and then to each ounce of strong solu-

tion add one drachm of a twenty grain solution* of potassium bromide, and flow over the plate. It will attain a good printing density, and not exhibit any of that flatness which is a usual characteristic of an over-exposed plate.

Pyrogallic Acid Intensifier.—At page 61 we gave an iron intensifier to use after the application of peroxide of hydrogen to the film. The ordinary form of intensifier used with wet plates may also be employed successfully. It stands as follows :—

Pyrogallic acid	2 grains
Citric acid	2 ,,
Water	1 ounce

If it be required to give local intensity to a plate after drying, an addition of equal parts of glycerine and the above may be advantageously employed. To each ounce of the above, five or six drops of the following should be added :—

Silver nitrate	20 grains
Water	1 ounce

This, like the iron intensifier, may be used in a dish; or, if the glycerine be added, the plates may be held on a pneumatic holder, and the intensification may proceed in the ordinary manner.

Reducing the Local Intensity of Negatives. — Local intensity may be reduced by abrading the film with very fine pumice and the finger; in other words, by

* Water...	1 ounce
Potassium bromide...	20 grains

rubbing away the film. Fine ink erasers may also be used, but it is needless to say that great care must be taken to prevent scratches being made on the film.

Obstinate Cases of Frilling.—In some batches of plates frilling is so obstinate that although collodion be applied the film has a tendency to curl off from the edges of the plate. It is advisable, when such is suspected, to run a brush with india-rubber solution round the edges, to prevent the water having access to that part of the film. When fixing such plates it not unfrequently happens that blisters appear, and if allowed to remain as they were will spoil the negative. To avoid this, we wash the plate under the tap till all the blisters join, and the film presents the appearance of a sack containing water. A prick at one corner of the plate lets this liquid free, and the washing can take place as usual. These obstinate cases of frilling usually occur through plates being prepared in very hot weather, and the film being dried without first setting.

Keeping Gelatine Emulsion.—When a gelatine emulsion has been prepared for use, and has set, it may be kept an unlimited time by cutting it into lumps of (say) half an inch wide, and allowing it to stand in alcohol; or, after setting in a flask or jar, the alcohol may simply be poured on it, and it will keep free from all decomposition. When required for use, the alcohol is poured off, and the jelly melted in the ordinary manner.

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